

Title (en)

TRACKING AND MANIPULATING CELLULAR RNA VIA NUCLEAR DELIVERY OF CRISPR/CAS9

Title (de)

VERFOLGUNG UND MANIPULATION VON ZELLULÄRER RNA ÜBER NUKLEARE FREISETZUNG VON CRISPR/CAS9

Title (fr)

SUIVI ET MANIPULATION D'ARN CELLULAIRE PAR ADMINISTRATION NUCLÉAIRE DE CRISPR/CAS9

Publication

EP 4163374 A1 20230412 (EN)

Application

EP 22195456 A 20161122

Priority

- US 201562259014 P 20151123
- EP 16822766 A 20161122
- US 2016063429 W 20161122

Abstract (en)

Cas9 polypeptides which target RNA and methods of using them are provided.

IPC 8 full level

C12N 15/113 (2010.01); **A61P 21/00** (2006.01); **A61P 25/14** (2006.01); **C07K 19/00** (2006.01); **C12N 9/22** (2006.01); **C12N 15/11** (2006.01)

CPC (source: EP US)

A61K 38/465 (2013.01 - EP US); **A61K 48/0058** (2013.01 - US); **A61P 21/00** (2018.01 - EP); **A61P 25/14** (2018.01 - EP);
C12N 9/22 (2013.01 - EP US); **C12N 15/111** (2013.01 - EP US); **C12N 15/113** (2013.01 - EP US); **C07K 2319/09** (2013.01 - EP US);
C07K 2319/80 (2013.01 - EP US); **C12N 2310/10** (2013.01 - US); **C12N 2310/20** (2017.05 - EP US); **Y02A 50/30** (2018.01 - EP US)

Citation (applicant)

- US 62259014 P
- US 2014053301 W 20140828
- US 6461864 B1 20021008 - SORIANO PHILIPPE [US], et al
- US 2006000668 W 20060110
- US 2014069730 W 20141211
- WO 2015089277 A1 20150618 - UNIV CALIFORNIA [US]
- WO 2015089277 A1 20150618 - UNIV CALIFORNIA [US]
- SANDER JDJOUNG JK: "CRISPR-Cas systems for editing, regulating and targeting genomes", NAT BIOTECHNOL., vol. 32, no. 4, 2014, pages 347 - 55, XP055481941, DOI: 10.1038/nbt.2842
- STERNBERG, S.H.REDDING, S.JINEK, M.GREENE, E.C.DOUDNA, J.A.: "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9", NATURE, vol. 507, no. 7490, 2014, pages 62 - 67, XP055161285, DOI: 10.1038/nature13011
- WU XKRIZ AJSHARP PA: "Target specificity of the CRISPR-Cas9 system", QUANT BIOL., vol. 2, no. 2, 2014, pages 59 - 70
- JIANG FTAYLOR DWCHEN JSKORNFELD JEZHOU KTHOMPSON AJNOGALES EDOUDNA JA.: "Structures of a CRISPR-Cas9 R-loop complex primed for DNA cleavage", SCIENCE, vol. 351, no. 6275, 2016, pages 867 - 71, XP05519565, DOI: 10.1126/science.aad8282
- HO ET AL., J CELL SCI, 2005
- STAALS RHZHU YTAYLOR DWKORNFELD JE ET AL.: "RNA Targeting by the Type III-A CRISPR-Cas Csm Complex of Thermus thermophilus", MOL CELL, vol. 56, 2014, pages 518 - 30, XP055233869, DOI: 10.1016/j.molcel.2014.10.005
- KODAMA ET AL., BIOTECHNIQUES, vol. 9, no. 5, 4 November 2010 (2010-11-04), pages 793 - 805
- WRIGHT AVSTERNBERG SHTAYLOR DWSTAAHL BTBARDALES JAKORNFELD JEDODNA JA.: "Rational design of a split-Cas9 enzyme complex", PROC NATL ACAD SCI USA, vol. 112, no. 10, 2015, pages 2984 - 9, XP055283739, DOI: 10.1073/pnas.1501698112
- LODISH ET AL.: "Molecular Cell Biology", 1999
- DUROCHER ET AL., NUCL. ACIDS RES., vol. 30, 2002, pages E9
- MASSIE ET AL., J. VIROL., vol. 72, 1998, pages 2289 - 2296
- RUNNING DEER ET AL., BIOTECHNOL. PROG., vol. 20, 2004, pages 880 - 889
- ZAMBROWICZ ET AL., PROC. NATL. ACAD. SCI., vol. 94, 1997, pages 3789 - 3794
- GENTZ ET AL., PROC. NATL. ACAD. SCI., vol. 86, 1989, pages 821 - 824
- WILSON ET AL., CELL, vol. 37, 1984, pages 767 - 778
- WANG XZAMORE PDHALL TM: "Crystal structure of a Pumilio homology domain", MOL CELL, vol. 7, 2001, pages 855 - 65
- SJOQUIST ET AL., EUR. J. BIOCHEM., vol. 29, 1972, pages 572 - 578
- HJELM ET AL., EUR. J. BIOCHEM., vol. 57, 1975, pages 395 - 403
- BJORCK ET AL., J. IMMUNOL., vol. 133, 1984, pages 969 - 974
- GUSS ET AL., EMBO J., vol. 5, 1986, pages 1567 - 1575
- AKERSTROM ET AL., J. BIOL. CHEM., vol. 261, 1986
- SIKKEMA, AMER. BIOTECH. LAB., vol. 7, 1989, pages 42
- ELIASSON ET AL., J. BIOL. CHEM., vol. 263, 1988, pages 4323 - 4327
- WANG YCHEONG CGHALL TMWANG Z: "Engineering splicing factors with designed specificities", NAT METHODS, vol. 6, 2009, pages 825 - 830
- LU JGETZ GMISKA EAALVAREZ-SAAVEDRA E ET AL.: "MicroRNA expression profiles classify human cancers", NATURE, vol. 435, 2005, pages 834 - 74
- PASCA SPPORTMANN TVOINEAGU IYAZAWA M ET AL.: "Using iPSC-derived neurons to uncover cellular phenotypes associated with Timothy syndrome", NAT MED, vol. 17, 2011, pages 1657 - 62, XP055253787, DOI: 10.1038/nm.2576
- MACKENZIE TASCHWARTZ GNCALDERONE HMGRAVEEL CR ET AL.: "Stromal Expression of miR-21 Identifies High-Risk Group in Triple-Negative Breast Cancer", AM J PATHOL, vol. 184, 2014, pages 3217 - 25
- GERSTBERGER SHAFNER MASCANO MTUSCHL T: "Evolutionary conservation and expression of human RNA-binding proteins and their role in human genetic disease", ADV EXP MED BIOL, vol. 825, 2014, pages 1 - 55
- DEJESUS-HERNANDEZ MMACKENZIE IRBOEVE BFBOXER AL ET AL.: "Expanded GGGGCC hexanucleotide repeat in noncoding region of C9orf72 causes chromosome 9p-linked FTD and ALS", NEURON, vol. 72, 2011, pages 245 - 56, XP028322560, DOI: 10.1016/j.neuron.2011.09.011
- RENTON AEMAJOUNIE EWAITE ASIMON-SANCHEZ J ET AL.: "A hexanucleotide repeat expansion in C9orf72 is the cause of chromosome 9p21-linked ALS-FTD", NEURON, vol. 72, 2011, pages 257 - 68, XP028322561, DOI: 10.1016/j.neuron.2011.09.010
- O'CONNELL, M.R.OAKES, B.L.STERNBERG, S.H.EAST-SELETSKY, A.KAPLAN, M.DOUDNA, J.A.: "Programmable RNA recognition and cleavage by CRISPR/Cas9", NATURE, vol. 516, 2014, pages 263 - 266, XP055168138, DOI: 10.1038/nature13769

- BEUTH BPENNEL SARNVIG KBMARTIN SR ET AL.: "Structure of a Mycobacterium tuberculosis NusA-RNA complex", EMBO J, vol. 24, 2005, pages 3576 - 87
- BRADDOCK DTLOUIS JMBABER JLLEEVENS D ET AL.: "Structure and dynamics of KH domains from FBP bound to single-stranded DNA", NATURE, vol. 415, 2002, pages 1051 - 6
- LAIRD-OFFRINGA LABELASCO JG: "Analysis of RNA-binding proteins by in vitro genetic selection: identification of an amino acid residue important for locking U1A onto its RNA target", PROC NATL ACAD SCI USA, vol. 92, 1995, pages 11859 - 63, XP000993415, DOI: 10.1073/pnas.92.25.11859
- FILIPOVSKA ARAZIF MFNYGARD KKRACKHAM O: "A universal code for RNA recognition by PUF proteins", NAT CHEM BIOL, vol. 7, 2011, pages 425 - 7, XP055952448, DOI: 10.1038/nchembio.577
- ZHANG WWANG YDONG SCHOUDHURY R ET AL.: "Treatment of type 1 myotonic dystrophy by engineering site-specific RNA endonucleases that target (CUG)(n) repeats", MOLECULAR THERAPY : JAM SOC GENE THER, vol. 22, 2014, pages 312 - 20, XP055952445, DOI: 10.1038/mt.2013.251
- MALI PYANG LHESVELT KMAACH J ET AL.: "RNA-Guided Human Genome Engineering via Cas9", SCIENCE, vol. 339, 2013, pages 823 - 6, XP055469277, DOI: 10.1126/science.1232033
- CHO SWKIM SKIM JMKIM JS: "Targeted genome engineering in human cells with the Cas9 RNA-guided endonuclease", NAT BIOTECHNOL, vol. 31, 2013, pages 230 - 2
- HWANG, W.Y.FU, Y.REYON, D.MAEDER, M.L.TSAI, S.Q.SANDER, J.D.PETERSON, R.T.YEH, J.R.JOUNG, J.K: "Efficient genome editing in zebrafish using a CRISPR-Cas system", NAT BIOTECHNOL, vol. 31, 2013, pages 227 - 229, XP055086625, DOI: 10.1038/nbt.2501
- JINEK MEAST ACHENG ALIN S ET AL.: "RNA-programmed genome editing in human cells", ELIFE, vol. 2, 2013, pages e00471, XP002699851, DOI: 10.7554/eLife.00471
- CONG, L.RAN, F.A.COX, D.LIN, S.BARRETTO, R.HABIB, N.HSU, P.D.WU, X.JIANG, W.MARRAFFINI, L.A. ET AL.: "Multiplex genome engineering using CRISPR/Cas systems", SCIENCE, vol. 339, 2013, pages 819 - 823, XP055400719, DOI: 10.1126/science.1231143
- CENCIC RMIURA HMALINA AROBERT F ET AL.: "Protospacer adjacent motif (PAM)-distal sequences engage CRISPR Cas9 DNA target cleavage", PLOS ONE, vol. 9, 2014, pages e109213
- KUSCU CARSLAN SSINGH RTHORPE J ET AL.: "Genome-wide analysis reveals characteristics of off-target sites bound by the Cas9 endonuclease", NAT BIOTECHNOL, vol. 32, 2014, pages 677 - 83, XP055382577, DOI: 10.1038/nbt.2916
- SWIECH LHEIDENREICH MBANERJEE AHABIB N ET AL.: "vivo interrogation of gene function in the mammalian brain using CRISPR-Cas9", NATURE BIOTECHNOL, vol. 33, 2015, pages 102 - 6, XP055176807, DOI: 10.1038/nbt.3055
- MADDALO DMANCHADO EONCEPCION CPBONETTI C ET AL.: "vivo engineering of oncogenic chromosomal rearrangements with the CRISPR/Cas9 system", NATURE, vol. 516, 2014, pages 423 - 7, XP055549335, DOI: 10.1038/nature13902
- DOW LEFISHER JO'ROURKE KPMULEY A ET AL.: "Inducible in vivo genome editing with CRISPR-Cas9", NATURE BIOTECHNOL, 2015
- ZURIS JATHOMPSON DBSHU YGUILINGER JP ET AL.: "Cationic lipid-mediated delivery of proteins enables efficient protein-based genome editing in vitro and in vivo", NATURE BIOTECHNOL, vol. 33, 2015, pages 73 - 80, XP055562063, DOI: 10.1038/nbt.3081
- MENG LWARD AJCHUN SBENNETT CF ET AL.: "Towards a therapy for Angelman syndrome by targeting a long non-coding RNA", NATURE, vol. 518, 2015, pages 409 - 12, XP055556384, DOI: 10.1038/nature13975
- HUA YSAHASHI KHUNG GRIGO F ET AL.: "Antisense correction of SMN2 splicing in the CNS rescues necrosis in a type III SMA mouse model", GENES DEV, vol. 24, 2010, pages 1634 - 44, XP055038360, DOI: 10.1101/gad.1941310
- PASSINI MABU JRICHARDS AMKINNECOM C ET AL.: "Antisense oligonucleotides delivered to the mouse CNS ameliorate symptoms of severe spinal muscular atrophy", SCIENCE TRANSL MED, vol. 3, 2011, pages 72 - 18, XP055275201, DOI: 10.1126/scitranslmed.3001777
- GILBERT LALARSON MHMORSUT LLIU Z ET AL.: "CRISPR-mediated modular RNA-guided regulation of transcription in eukaryotes", CELL, vol. 154, 2013, pages 442 - 51, XP055115843, DOI: 10.1016/j.cell.2013.06.044
- QI, L.S.LARSON, M.H.GILBERT, L.A.DOUDNA, J.A.WEISSMAN, J.S.ARKIN, A.P.LIM, W.A.: "Repurposing CRISPR as an RNA-guided platform for sequence-specific control of gene expression", CELL, vol. 152, 2013, pages 1173 - 1183, XP055346792, DOI: 10.1016/j.cell.2013.02.022
- MUDDASHETTY RSNALAVADI VCGROSS CYAO X ET AL.: "Reversible inhibition of PSD-95 mRNA translation by miR-125a, FMRP phosphorylation, and mGluR signaling", MOL CELL, vol. 42, 2011, pages 673 - 88
- SHESTAKOVA EASINGER RHONDEELIS J.: "The physiological significance of beta-actin mRNA localization in determining cell polarity and directional motility", PROC NATL ACAD SCI USA, vol. 98, 2001, pages 7045 - 50
- DONNELLY CJWILLIS DEXU MTEP C ET AL.: "Limited availability of ZBP1 restricts axonal mRNA localization and nerve regeneration capacity", EMBO J, vol. 30, 2011, pages 4665 - 77
- GRAVELEY BRMANIATIS T: "Arginine/serine-rich domains of SR proteins can function as activators of pre-mRNA splicing", MOL CELL, vol. 1, 1998, pages 765 - 71, XP002573356, DOI: 10.1016/S1097-2765(00)80076-3
- LOVCI MTGHANEM DMARR HARNOLD J ET AL.: "Rbfox proteins regulate alternative mRNA splicing through evolutionarily conserved RNA bridges", NAT STRUCT MOL BIOL, vol. 20, 2013, pages 1434 - 42
- WEYN-VANHENTENRYCK SMMELE AYAN QSUN S ET AL.: "HITS-CLIP and integrative modeling define the Rbfox splicing-regulatory network linked to brain development and autism", CELL REP, vol. 6, 2014, pages 1139 - 52
- YEO GWCOUFAL NGLIANG TYPENG GE ET AL.: "An RNA code for the FOX2 splicing regulator revealed by mapping RNA-protein interactions in stem cells", NAT STRUCT MOL BIOL, vol. 16, 2009, pages 130 - 7
- HUA YVICKERS TAOKUNOLA LHBENNETT CF ET AL.: "Antisense masking of an hnRNP A1/A2 intronic splicing silencer corrects SMN2 splicing in transgenic mice", AM J HUM GENET, vol. 82, 2008, pages 834 - 48, XP002692598, DOI: 10.1016/j.ajhg.2008.01.014
- NISSIM-RAFINIA MKEREM B.: "Splicing regulation as a potential genetic modifier", TRENDS GENET, vol. 18, 2002, pages 123 - 7, XP004340605, DOI: 10.1016/S0168-9525(01)02619-1
- GEISLER SCOLLER J.: "RNA in unexpected places: long non-coding RNA functions in diverse cellular contexts", NAT REV MOL CELL BIOL, vol. 14, 2013, pages 699 - 712, XP055386225, DOI: 10.1038/nrm3679
- ESVELT, K.M.MALI, P.BRAFF, J.L.MOOSBURNER, M.YAUNG, S.J.CHURCH, G.M.: "Orthogonal Cas9 proteins for RNA-guided gene regulation and editing", NAT METHODS, vol. 10, 2013, pages 1116 - 1121, XP055128928, DOI: 10.1038/nmeth.2681
- RATH AKRENTMEISTER A: "Genetically encoded tools for RNA imaging in living cells", CURR OPIN BIOTECHNOL, vol. 31C, 2014, pages 42 - 9
- BERTRAND, E.CHARTRAND, P.SCHAEFER, M.SHENOY, S.M.SINGER, R.H.LONG, R.M.: "Localization of ASH1 mRNA particles in living yeast", MOL CELL, vol. 2, 1998, pages 437 - 445, XP002455868, DOI: 10.1016/S1097-2765(00)80143-4
- PARK HYLM HYOON YJFOLLENZI A ET AL.: "Visualization of dynamics of single endogenous mRNA labeled in live mouse", SCIENCE, vol. 343, 2014, pages 422 - 4
- PAIGE JSWU KYJAFFREY SR: "RNA mimics of green fluorescent protein", SCIENCE, vol. 333, 2011, pages 642 - 6, XP055044003, DOI: 10.1126/science.1207339
- STRACK RLDISNEY MDJAFFREY SR: "A superfolder Spinach2 reveals the dynamic nature of trinucleotide repeat-containing RNA", NAT METHODS, vol. 10, 2013, pages 1219 - 24
- STRACK RLDISNEY MDJAFFREY SR: "Nat Methods", vol. 10, 2013, article "A superfolder Spinach2 reveals the dynamic nature of trinucleotide repeat-containing RNA", pages: 1219 - 24
- SUNBUL MJASCHKE A: "Contact-mediated quenching for RNA imaging in bacteria with a fluorophore-binding aptamer", ANGEW CHEM INT ED ENGL, vol. 52, 2013, pages 13401 - 4, XP055655742, DOI: 10.1002/anie.201306622
- SHIN IRAY JGUPTA VILGU M ET AL.: "Live-cell imaging of Pol II promoter activity to monitor gene expression with RNA IMAGEtag reporters", NUCLEIC ACIDS RES, vol. 42, 2014, pages e90
- RACKHAM OBROWN CM: "Visualization of RNA-protein interactions in living cells: FMRP and IMP1 interact on mRNAs", EMBO J, vol. 23, 2004, pages 3346 - 55, XP055550025, DOI: 10.1038/sj.emboj.7600341
- LIONNET TCZAPLINSKI KDARZACQ XSHAV-TAL Y ET AL.: "A transgenic mouse for in vivo detection of endogenous labeled mRNA", NATURE METHODS, vol. 8, 2011, pages 165 - 70

- FUSCO DACCORNERO NLAVOIE BSHENOY SM ET AL.: "Single mRNA molecules demonstrate probabilistic movement in living mammalian cells", *CURR BIOL*, vol. 13, 2003, pages 161 - 7
- TYAGI SKRAMER FR: "Molecular beacons: Probes that fluoresce upon hybridization", *NAT BIOTECHNOL*, vol. 14, 1996, pages 303 - 8, XP000196024, DOI: 10.1038/nbt0396-303
- OZAWA TNATORI YSATO MUMEZAWA Y: "Imaging dynamics of endogenous mitochondrial RNA in single living cells", *NAT METHODS*, vol. 4, 2007, pages 413 - 9, XP002573359, DOI: 10.1038/NMETH1030
- KEDERSHA NANDERSON P: "Mammalian stress granules and processing bodies", *METHODS ENZYMOL*, vol. 431, 2007, pages 61 - 81
- DUEBER JEWU GCMALMIRCHEGINI GRMOON TS ET AL.: "Synthetic protein scaffolds provide modular control over metabolic flux", *NAT BIOTECHNOL*, vol. 27, 2009, pages 753 - 9, XP008144815
- SAMPSON, T.R.SAROJ, S.D.LLEWELLYN, A.C.TZENG, Y.L.WEISS, D.S.: "A CRISPR/Cas system mediates bacterial innate immune evasion and virulence", *NATURE*, vol. 497, 2013, pages 254 - 257, XP055265324, DOI: 10.1038/nature12048
- WIEDENHEFT, B.STERNBERG, S.H.DOUDNA, J.A.: "RNA-guided genetic silencing systems in bacteria and archaea", *NATURE*, vol. 482, 2012, pages 331 - 338, XP002723433, DOI: 10.1038/nature10886
- "Efficient genome editing in zebrafish using a CRISPR-Cas system.", *NAT BIOTECHNOL*, vol. 31, 2013, pages 227 - 229
- LI, D.QIU, Z.SHAO, Y.CHEN, Y.GUAN, Y.LIU, M.LI, Y.GAO, N.WANG, L.LU, X. ET AL.: "Heritable gene targeting in the mouse and rat using a CRISPR-Cas system", *NAT BIOTECHNOL*, vol. 31, 2013, pages 681 - 683, XP055372215, DOI: 10.1038/nbt.2661
- NAKAYAMA, T.FISH, M.B.FISHER, M.OOMEN-HAJAGOS, J.THOMSEN, G.H.GRAINGER, R.M.: "Simple and efficient CRISPR/Cas9-mediated targeted mutagenesis in *Xenopus tropicalis*", *GENESIS*, vol. 51, 2013, pages 835 - 843, XP055598236, DOI: 10.1002/dvg.22720
- SANDER, J.D.JOUNG, J.K.: "CRISPR-Cas systems for editing, regulating and targeting genomes", *NAT BIOTECHNOL*, vol. 32, 2014, pages 347 - 355, XP055481941, DOI: 10.1038/nbt.2842
- YANG, D.XU, J.ZHU, T.FAN, J.LAI, L.ZHANG, J.CHEN, Y.E.: "Effective gene targeting in rabbits using RNA-guided Cas9 nucleases", *J MOL CELL BIOL*, vol. 6, 2014, pages 97 - 99, XP055495958, DOI: 10.1093/jmcb/mjt047
- CHEN, B.GILBERT, L.A.CIMINI, B.A.SCHNITZBAUER, J.ZHANG, W.LI, G.W.PARK, J.BLACKBURN, E.H.WEISSMAN, J.S.QI, L.S. ET AL.: "Dynamic imaging of genomic loci in living human cells by an optimized CRISPR/Cas system", *CELL*, vol. 155, 2013, pages 1479 - 1491, XP028806611, DOI: 10.1016/j.cell.2013.12.001
- URNOV, F.D., REBAR, E.J., HOLMES, M.C., ZHANG, H.S., AND GREGORY, P.D.: "Genome editing with engineered zinc finger nucleases", *NAT REV GENET*, vol. 11, 2010, pages 636 - 646, XP055198280, DOI: 10.1038/nrg2842
- FOUTS, D.E.TRUE, H.L.CELANDER, D.W.: "Functional recognition of fragmented operator sites by R17/MS2 coat protein, a translational repressor", *NUCLEIC ACIDS RES*, vol. 25, 1997, pages 4464 - 4473, XP002146303, DOI: 10.1093/nar/25.22.4464
- BUXBAUM, A.R.WU, B.SINGER, R.H.: "Single beta-actin mRNA detection in neurons reveals a mechanism for regulating its translatability", *SCIENCE*, vol. 343, 2014, pages 419 - 422
- GARCIA, J.F.PARKER, R.: "MS2 coat proteins bound to yeast mRNAs block 5' to 3' degradation and trap mRNA decay products: implications for the localization of mRNAs by MS2-MCP system", *RNA*, vol. 21, 2015, pages 1393 - 1395
- MANDERS, E.M., STAP, J., BRAKENHOFF, G.J., VAN DRIEL, R., AND ATEN, J.A.: "Dynamics of three-dimensional replication patterns during the S-phase, analysed by double labelling of DNA and confocal microscopy", *J CELL SCI*, vol. 103, no. 3, 1992, pages 857 - 862
- BUCHAN, J.R.PARKER, R.: "Eukaryotic stress granules: the ins and outs of translation", *MOL CELL*, vol. 36, 2009, pages 932 - 941
- LI, Y.R.KING, O.D.SHORTER, J.GITLER, A.D.: "Stress granules as crucibles of ALS pathogenesis", *J CELL BIOL*, vol. 201, 2013, pages 361 - 372
- UNSWORTH, H., RAGUZ, S., EDWARDS, H.J., HIGGINS, C.F., AND YAGUE, E.: "mRNA escape from stress granule sequestration is dictated by localization to the endoplasmic reticulum", *FASEB J*, vol. 24, 2010, pages 3370 - 3380
- TOURRIERE, H.CHEBLI, K.ZEKRI, L.COURSELAUD, B.BLANCHARD, J.M.BERTRAND, E.TAZI, J.: "The RasGAP-associated endoribonuclease G3BP assembles stress granules", *J CELL BIOL*, vol. 160, 2003, pages 823 - 831, XP055615984, DOI: 10.1083/jcb.200212128
- CHEONG, C.G.HALL, T.M.: "Engineering RNA sequence specificity of Pumilio repeats", *PROC NATL ACAD SCI USA*, vol. 103, 2006, pages 13635 - 13639, XP055564297, DOI: 10.1073/pnas.0606294103
- WANG, X.MCLACHLAN, J.ZAMORE, P.D.HALL, T.M.: "Modular recognition of RNA by a human pumilio-homology domain", *CELL*, vol. 110, 2002, pages 501 - 512, XP055608842, DOI: 10.1016/S0092-8674(02)00873-5
- HALE, C.R.ZHAO, P.OLSON, S.DUFF, M.O.GRAVELEY, B.R.WELLS, L.TERNS, R.M.TERNS, M.P.: "RNA-guided RNA cleavage by a CRISPR RNA-Cas protein complex", *CELL*, vol. 139, 2009, pages 945 - 956, XP055038712, DOI: 10.1016/j.cell.2009.07.040
- PRICE, A.A.SAMPSON, T.R.RATNER, H.K.GRAKOU, A.WEISS, D.S.: "Cas9-mediated targeting of viral RNA in eukaryotic cells", *PROC NATL ACAD SCI USA*, vol. 112, 2015, pages 6164 - 6169, XP055335247, DOI: 10.1073/pnas.1422340112
- FU, Y.SANDER, J.D.REYON, D.CASCIO, V.M.JOUNG, J.K.: "Improving CRISPR-Cas nuclease specificity using truncated guide RNAs", *NAT BIOTECHNOL*, vol. 32, 2014, pages 279 - 284, XP055259718, DOI: 10.1038/nbt.2808
- "Multiplex genome engineering using CRISPR/Cas systems.", *SCIENCE*, vol. 339, 2013, pages 819 - 823
- DELEBECQUE, C.J.LINDNER, A.B.SILVER, P.A.ALDAYE, F.A.: "Organization of intracellular reactions with rationally designed RNA assemblies", *SCIENCE*, vol. 333, 2011, pages 470 - 474
- SACHDEVA, G.GARG, A.GODDING, D.WAY, J.C.SILVER, P.A.: "vivo co-localization of enzymes on RNA scaffolds increases metabolic production in a geometrically dependent manner", *NUCLEIC ACIDS RES*, vol. 42, 2014, pages 9493 - 9503, XP055727747, DOI: 10.1093/nar/gku617
- DOW, L.E.FISHER, J.O'ROURKE, K.P.MULEY, A.KASTENHUBER, E.R.LIVSHITS, G.TSCHAHARGANEH, D.F.SOCCI, N.D.LOWE, S.W.: "Inducible in vivo genome editing with CRISPR-Cas9", *NAT BIOTECHNOL*, vol. 33, 2015, pages 390 - 394, XP055266912, DOI: 10.1038/nbt.3155
- SWIECH, L.HEIDENREICH, M.BANERJEE, A.HABIB, N.LI, Y.TROMBETTA, J.SUR, M.ZHANG, F.: "alternative embodiments, exemplary RCas9 as provided herein can be used for in vivo interrogation of gene function in the mammalian brain using CRISPR-Cas9", *NAT BIOTECHNOL*, vol. 33, 2015, pages 102 - 106
- ZURIS, J.A.THOMPSON, D.B.SHU, Y.GUILINGER, J.P.BESSEN, J.L.HU, J.H.MAEDER, M.L.JOUNG, J.K.CHEN, Z.Y.LIU, D.R.: "alternative embodiments, provided are cationic lipid-mediated delivery of exemplary RCas9 as provided herein to enable efficient protein-based genome editing in vitro and in vivo", *NAT BIOTECHNOL*, vol. 33, 2015, pages 73 - 80
- BENNETT, C.F.SWAYZE, E.E.: "RNA targeting therapeutics: molecular mechanisms of antisense oligonucleotides as a therapeutic platform", *ANNU REV PHARMACOL TOXICOL*, vol. 50, 2010, pages 259 - 293, XP055055378, DOI: 10.1146/annurev.pharmtox.010909.105654
- SCHINDELIN, J.ARGANDA-CARRERAS, I.FRISE, E.KAYNIG, V.LONGAIR, M.PIETZSCH, T.PREIBISCH, S.RUEDEN, C.SAALFELD, S.SCHMID, B. ET AL.: "Fiji: an open-source platform for biological-image analysis", *NAT METHODS*, vol. 9, 2012, pages 676 - 682, XP055343835, DOI: 10.1038/nmeth.2019
- WRIGHT ET AL.: "Rational design of a split-Cas9 enzyme complex", *PNAS*, vol. 112, 2015, pages 2984 - 2989, XP055283739, DOI: 10.1073/pnas.1501698112
- BASHOR CJHELMAN NCYAN SLIM WA: "Using engineered scaffold interactions to reshape MAP kinase pathway signaling dynamics", *SCIENCE*, vol. 319, 2008, pages 1539 - 43, XP055792519, DOI: 10.1126/science.1151153
- BATRA ET AL.: "Loss of MBNL Leads to Disruption of Developmentally Regulated Alternative Polyadenylation in RNA-Mediated Disease", *MOL CELL*, vol. 56, no. 2, 2014, pages 311 - 322, XP029084882, DOI: 10.1016/j.molcel.2014.08.027
- CHEONG, C.G.HALL, T.M.: "Engineering RNA sequence specificity of Pumilio repeats", *PROC NATL ACAD SCI U S A*, vol. 103, 2006, pages 13635 - 13639, XP055564297, DOI: 10.1073/pnas.0606294103
- CHOU, H.H.HSIA, A.P.MOONEY, D.L.SCHNABLE, P.S.: "Picky: oligo microarray design for large genomes", *BIOINFORMATICS*, vol. 20, 2004, pages 2893 - 2902
- HALO ET AL.: "NanoFlares for the detection, isolation, and culture of live tumor cells from human blood", *PNAS* DOI: 10.1073/PNAS.1418637111
- HENDEL, A.BAK, R.O.CLARK, J.T.KENNEDY, A.B.RYAN, D.E.ROY, S.STEINFELD, I.LUNSTAD, B.D.KAISER, R.J.WILKENS, A.B.: "Chemically modified guide RNAs enhance CRISPR-Cas genome editing in human primary cells", *NATURE BIOTECHNOLOGY*, vol. 33, 2015, pages 985 - 989, XP055548372, DOI: 10.1038/nbt.3290

- HO ET AL.: "Colocalization of muscleblind with RNA foci is separable from mis-regulation of alternative splicing in myotonic dystrophy", J CELL SCI., vol. 118, no. 13, 2005, pages 2923 - 2933, XP008107836, DOI: 10.1242/jcs.02404
- HUA ET AL.: "Peripheral SMN restoration is essential for long-term rescue of a severe spinal muscular atrophy mouse model", NATURE, vol. 478, no. 7367, 5 October 2011 (2011-10-05), pages 123 - 6, XP055038358, DOI: 10.1038/nature10485
- KANADIA RNJOHNSTONE KAMANKODI ALUNGU CTHORNTON CAESSON DTIMMERS AMHAUSWIRTH WWSWANSON MS: "A muscleblind knockout model for myotonic dystrophy", SCIENCE, vol. 302, no. 5652, 2003, pages 1978 - 80, XP002996065, DOI: 10.1126/science.1088583
- LONG CAMOASII LMIREAULT AAMCANALLY JR LI HSANCHEZ-ORTIZ EBHATTACHARYYA SSHELTON JMBASSEL-DUBY ROLSON EN: "Postnatal genome editing partially restores dystrophin expression in a mouse model of muscular dystrophy", SCIENCE, vol. 351, no. 6271, 2016, pages 400 - 3, XP055575397, DOI: 10.1126/science.aad5725
- MIYANOHARA AKAMIZATO KJUHAS SJUHASOVA JNAVARRO MMARSALA SLUKACOVA NHRUSKA-PLOCHAN MCURTIS EGABEL B: "Potent spinal parenchymal AAV9-mediated gene delivery by subpial injection in adult rats and pigs", MOL THER METHODS CLIN DEV, vol. 3, 2016, pages 16046, XP055475002, DOI: 10.1038/mtm.2016.46
- MOUISEL EBLONDET BESOURROU PCHATONNET AMOLGO JFERRY A: "Outcome of acetylcholinesterase deficiency for neuromuscular functioning", NEUROSCI RES, vol. 55, no. 4, 2006, pages 389 - 96, XP024955936, DOI: 10.1016/j.neures.2006.05.002
- ORENGO JPCHAMBON PMETZGER DMOSIER DRNIPES GJCOOPER TA: "Expanded CTG repeats within the DMPK 3' UTR causes severe skeletal muscle wasting in an inducible mouse model for myotonic dystrophy", PROC NATL ACAD SCI USA., vol. 105, no. 7, 2008, pages 2646 - 51
- "Cas9-mediated targeting of viral RNA in eukaryotic cells.", PROC NATL ACAD SCI USA, vol. 112, 2015, pages 6164 - 6169
- SACHDEVA, G.GARG, A.GODDING, D.WAY, J.C.SILVER, P.A.: "In vivo co-localization of enzymes on RNA scaffolds increases metabolic production in a geometrically dependent manner", NUCLEIC ACIDS RES, vol. 42, 2014, pages 9493 - 9503, XP055727747, DOI: 10.1093/nar/gku617
- SHESTAKOVA EASINGER RHONDEELIS J.: "The physiological significance of beta -actin mRNA localization in determining cell polarity and directional motility", PROC NATL ACAD SCI USA, vol. 98, 2001, pages 7045 - 50
- STEPTO AGALLO JMSHAW CEHIRTH F: "Modelling C90RF72 hexanucleotide repeat expansion in amyotrophic lateral sclerosis and frontotemporal dementia", ACTA NEUROPATHOL., vol. 127, no. 3, 2014, pages 377 - 89, XP055294503, DOI: 10.1007/s00401-013-1235-1
- SWIECH, L.HEIDENREICH, M.BANERJEE, A.HABIB, N.LI, Y.TROMBETTA, J.SUR, M.ZHANG, F.: "In vivo interrogation of gene function in the mammalian brain using CRISPR-Cas9", NAT BIOTECHNOL, vol. 33, 2015, pages 102 - 106, XP055176807, DOI: 10.1038/nbt.3055
- "An integrated encyclopedia of DNA elements in the human genome.", NATURE, vol. 489, 2012, pages 57 - 74
- WERNERSSON, R.NIELSEN, H.B.: "OligoWiz 2.0-integrating sequence feature annotation into the design of microarray probes", NUCLEIC ACIDS RES, vol. 33, 2005, pages 611 - 615
- WHEELER TMLUECK JDSWANSON MSDIRKSEN RTTHORNTON CA: "Correction of C1C-1 splicing eliminates chloride channelopathy and myotonia in mouse models of myotonic dystrophy", J CLIN INVEST., vol. 117, no. 12, 2007, pages 3952 - 7
- YANG YWANG LBELL PMCMENAMIN DHE ZWHITE JYU HXU CMORIZONO HMUSUNURU K: "A dual AAV system enables the Cas9-mediated correction of a metabolic liver disease in newborn mice", NAT BIOTECHNOL., vol. 34, no. 3, 2016, pages 334 - 8, XP055569763, DOI: 10.1038/nbt.3469
- ZURIS, J.A.THOMPSON, D.B.SHU, Y.GUILINGER, J.PBESSEN, J.L.HU, J.H.MAEDER, M.L.JOUNG, J.K.CHEN, Z.Y.LIU, D.R.: "Cationic lipid-mediated delivery of proteins enables efficient protein-based genome editing in vitro and in vivo", NAT BIOTECHNOL, vol. 33, 2015, pages 73 - 80, XP055562063, DOI: 10.1038/nbt.3081

Citation (search report)

- [IA] WO 2015089351 A1 20150618 - BROAD INST INC [US], et al
- [AD] WO 2015089277 A1 20150618 - UNIV CALIFORNIA [US]
- [A] WO 2014113493 A1 20140724 - UNIV EMORY [US]
- [AP] WO 2016106236 A1 20160630 - BROAD INST INC [US], et al
- [A] MITCHELL R. O'CONNELL ET AL: "Programmable RNA recognition and cleavage by CRISPR/Cas9", NATURE, vol. 516, no. 7530, 28 September 2014 (2014-09-28), pages 263 - 266, XP055168138, ISSN: 0028-0836, DOI: 10.1038/nature13769
- [A] ARYN A. PRICE ET AL: "Cas9-mediated targeting of viral RNA in eukaryotic cells", PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, vol. 112, no. 19, 12 May 2015 (2015-05-12), US, pages 6164 - 6169, XP055335247, ISSN: 0027-8424, DOI: 10.1073/pnas.1422340112
- [A] DAVID A. NELLES ET AL: "Applications of Cas9 as an RNA-programmed RNA-binding protein", BIOESSAYS, vol. 37, no. 7, 16 April 2015 (2015-04-16), GB, pages 732 - 739, XP055345194, ISSN: 0265-9247, DOI: 10.1002/bies.201500001
- [AP] NELLES DAVID A ET AL: "Programmable RNA Tracking in Live Cells with CRISPR/Cas9", CELL, CELL PRESS, US, vol. 165, no. 2, 17 March 2016 (2016-03-17), pages 488 - 496, XP029496630, ISSN: 0092-8674, DOI: 10.1016/J.CELL.2016.02.054
- [T] BATRA RANJAN ET AL: "Elimination of Toxic Microsatellite Repeat Expansion RNA by RNA-Targeting Cas9", CELL, ELSEVIER, AMSTERDAM NL, vol. 170, no. 5, 10 August 2017 (2017-08-10), pages 899, XP085170516, ISSN: 0092-8674, DOI: 10.1016/J.CELL.2017.07.010

Designated contracting state (EPC)

AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

DOCDB simple family (publication)

US 2017145394 A1 20170525; AU 2016359629 A1 20180607; AU 2016359629 B2 20230309; CA 3005968 A1 20170601; CN 109072235 A 20181221; CN 109072235 B 20230228; EP 3380613 A1 20181003; EP 3380613 B1 20221026; EP 4163374 A1 20230412; ES 2930643 T3 20221220; JP 2019500899 A 20190117; JP 2022081503 A 20220531; PT 3380613 T 20221202; SG 10202004557Q A 20200629; SG 11201804372P A 20180628; US 11667903 B2 20230606; US 2019040370 A1 20190207; US 2020239863 A1 20200730; US 2023365951 A1 20231116; WO 2017091630 A1 20170601; WO 2017091630 A4 20170824

DOCDB simple family (application)

US 201615359567 A 20161122; AU 2016359629 A 20161122; CA 3005968 A 20161122; CN 201680079817 A 20161122; EP 16822766 A 20161122; EP 22195456 A 20161122; ES 16822766 T 20161122; JP 2018545579 A 20161122; JP 2022023996 A 20220218; PT 16822766 T 20161122; SG 10202004557Q A 20161122; SG 11201804372P A 20161122; US 2016063429 W 20161122; US 201816054298 A 20180803; US 202016794918 A 20200219; US 202318306673 A 20230425